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THE ORIGIN, GROWTH AND SIGNIFICANCE OF THE MENTAL HYGIENE MOVEMENT[1]

By Dr. WILLIAM A. WHITE

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OF the many mixed feelings with which I greet you, that which is uppermost at the moment is that at some day in the future, perhaps not far distant, those who follow us will look back upon this occasion and realize that it was a historic moment in the development of the movement for mental health. I myself personally have faith that this is so, and I have no doubt that many of you also have that same faith. Certainly those of you who have come from far distant lands must feel that this cause which we represent is one of no small moment.

It is fitting that this congress should have been so arranged as to open on this day, the sixth of May, which is the twenty-second anniversary of the formation of the first mental hygiene society in the world—the Connecticut Society for Mental Hygiene, about the origin of which you have already heard. It is significant that the same group that was responsible for this Connecticut society a few months later—namely, in February of the following year—brought into existence the National Committee for Mental Hygiene, and thus almost at once gave the mental hygiene movement a national complexion. And now at the end of these twenty-two years mental health has become of international significance and this congress is the outstanding indication of the spread of the mental hygiene movement over the face of the earth.

As you have just heard Mr. Beers say, this afternoon the Organizing Committee of the International Congress had its meeting in the Academy of Sciences Building and created an International Committee for Mental Hygiene, thus making this international move-

[1] Presidential address delivered at the First International Congress on Mental Hygiene, Washington, D. C., May 6, 1930.

ment permanent, crystallizing it in the form of an organization and insuring future international congresses at periods of five years, with intermediate meetings of smaller dimensions at such times and places as circumstances might indicate.

You have already seen and heard Mr. Beers. I am, however, moved to say in addition to what you have already heard, and perhaps to add to what you may already know, that it was the mind of Mr. Beers that originally conceived the mental hygiene movement and visioned its possibilities. For a hundred years patients had been leaving our public institutions for mental diseases with a sense that if they had recovered, they did not owe it to the way they had been treated. In numerous instances they must have felt outraged at the experiences they looked back upon—at the cruelty, the callousness, the lack of sympathy with which they had been confronted during their confinement. But it was given to only one man who had had such experiences to have these memories of his treatment strike deep to the very core of his being, and there, instead of rankling and making him resentful, take root and grow and produce the fruit that is now the mental hygiene movement. He had been outraged as these others had been, but by some strange alchemy of his mind these outrages did not have the same effect. They stirred him to creative activity. They stimulated him to find the reasons for it all, to try to correct what he felt, not as personal animosity and antagonism to him, but as ignorance and stupidity, to try to see that those who followed him should be saved such experiences as he had passed through. This man, the genius of whose mind among a million saw opportunity where no one else had seen it for a century, this man, as you well know, is Mr. Clifford W. Beers; and that you may realize the full measure of his great work, remember that not only has he been willing these twenty years to devote his time, strength, everything that he had to the success of the mental hygiene movement, but that he has been willing to strip his soul and tell his experiences to the world in that wonderful book of his, "A Mind That Found Itself." It is because of his willingness to do this that I am able to speak as I do about him to-night. The movement as it stands to-day owes him a debt that it can never pay. Who can predict the extent to which future generations may in turn be indebted for what he has given the world, the suffering that will be obviated, the understanding and intelligent treatment that will be encouraged.

My friends, there are one million young people walking the streets of the United States to-day who, if the statisticians are able to tell us the facts about the future, are necessarily doomed to spend some of their time before they die in institutions for mental disease. It is only by appreciating such staggering figures that it is possible to understand the necessity for this movement throughout the world.

The way in which the mental hygiene movement originally came into being seems to me of the utmost significance. It was not the outgrowth of any philosophy started by a group who were bound to prove that the tenets of that philosophy were sound. It was infinitely more simple. Its objective—and its sole objective except for some broader formulations regarding prevention and research that appeared even in its first statements—was in its earliest days the improvement of the care of the so-called "insane." Mr. Beers was convinced by personal experience that this care was not what it should be, that its defects were due to ignorance largely, to lack of understanding the mental patient and of proper standards of care in institutions, and he set about in a constructive way to correct the evils as he saw them. As you see, a perfectly simple procedure. Certain things were wrong. What could be done to improve them? Here was a program with which no one could find fault. As soon as presented, it necessarily found agreement on all hands. And so the movement was launched in this way. The attitude of mind that animated those who were originally involved was one, with which we are perfectly familiar. It has been the attitude through the ages of the physician. He sees things that produce unhappiness and suffering and he tries to correct them. He does not wait until all the scientific and philosophical questions that could be raised surrounding the particular situation are solved, nor does he alter his treatment according to whether he considers his various types of patient more or less worth while. Mental hygiene did not stop to solve the metaphysical, philosophical and theological problems that have always been associated with the study of the mind. It did not seriously consider such questions as the freedom of the will or the relation of body and mind or the moral factors that were involved in mental illness, but accepted man just as it found him, with his hates and loves, his hopes, fears, wishes, aspirations and ideals, and tried to find a better solution for his difficulties than he had been able to. It is precisely the attitude of the surgeon at the operating table to whom is brought a man with a bullet wound. He does not stop to inquire how the wound was received, whether in the commission of a crime or in the defense of his home, but proceeds at once to see how matters can be made better. He feels it to be his duty to give the best he has of his skill then and there to that particular patient without qualification. That is what the practice of medicine means to him and has meant down the ages. Back of this way of going at things lies the tacit assumption

that human life is in itself valuable, that it is worth while to save it and that the way in which it is lived can often be improved with a little help.

Naturally it was not long until, as the result of the application of such methods to the mentally ill, it became quite obvious that the field of possibilities was considerably larger, and the program that had been found useful for patients in the public institutions for mental disease was subsequently modified and adapted to other types of individuals, such as defectives and criminals. The net result I do not need to tell you. Institutions for the mentally ill have been inestimably benefited by the mental hygiene movement, institutions for defectives probably to a less extent and prisons perhaps the least of all, but active measures are being taken to bring to these people also some measure of relief.

While matters were progressing along these lines the concept of mental illness was being enlarged to include a great many things besides the types that we were accustomed to see in public institutions. Not only were the minor psychoses and the neuroses included, but all forms of social maladjustment and even of unhappiness were seen to have mechanisms quite the same as the more serious conditions with which we were more familiar. The mental diseases of the public institutions were obviously end products of many years of bad mental hygiene, and so the question at once arose as to the possibility of cutting off the source of mental disease at its origin by getting back to the beginnings and correcting the difficulties at that point. So there developed the application of mental hygiene to the school and to the educational system. In the meantime various forms of maladjustment, in occupation particularly, had received attention, and industry was becoming interested in trying to effect a happier relation between the employee and his job and to prevent the great cost incident to a large turnover in industrial establishments. The army and the navy realized the importance of preventive methods and undertook the earlier recognition of mental defect and disorder, with a view to saving both the military establishment and the individual unnecessary expenditures of time and effort.

All these things and many more have happened with bewildering rapidity, and it has been next to impossible to keep up with the demands that have been made upon mental hygiene from all these various sources. In order to understand their significance more fully, it is necessary to remember that about the same time that the mental hygiene movement started, a very great change took place in the field of psychiatry. To the end of the nineteenth century mental disease had remained at the descriptive stage of development. It was still collecting and classifying its material. But with the beginning of the present century there came an effort to understand the meaning and significance of this material. Psychiatry attempted to find the causes, the tendencies, that lay back of the mental symptoms and that would, therefore, serve to explain their meanings, and in doing so it developed a technique of procedure that was analytic in type and served, as it were, the purpose of dissecting out the various psychological tendencies from one another so that they could be seen more nearly in pure culture and thus understood. This technique resulted in the development of an entirely new psychology based largely upon the emotions and upon those tendencies which lie beneath the threshold of consciousness, rather than upon the intelligence and those things of which we are clearly aware, which were more particularly stressed in the last century. Thus has grown up by analogy an anatomy and a physiology of the mind which disclose quite as multitudinous and complicated a set of structures and functions as we are all familiar with in the body. This new outlook, pregnant with such infinite possibilities, proved an enormous stimulus and has had much to do with vitalizing the movement for mental hygiene, which has taken over here and there as it could the various concepts from psychotherapy, psychopathology and psychiatry that it found useful.

While the spirit that animates the mental hygiene movement is in essence that of the physician, still methods of dealing with mental disorder and ways of thinking about it are in many respects quite different from those to which the physician has heretofore been accustomed. The several organs of the body have a different value from that which they had in the days when medicine was altogether the medicine of the body. Physical health was then the objective, even sometimes the physical integrity of a particular organ, in the mind of the specialist, whereas to-day we see the individual, not from the point of view of the integrity of his several organs, but as a social unit; the main significance of his several organs has shifted and, instead of presenting ends in themselves, they have importance in the scheme of the individual's life because of their ability to serve him, their capacity or incapacity to be of assistance in helping him bring to pass his ideals.

In all these ways mental hygiene has developed, and finally we see the movement separating out into three methods of procedure: first and earliest, a therapeutics based upon the control of the stimuli to which the organism is subjected by its environment; secondly, a psychotherapeutics that endeavored to change the individual from within, and thirdly, prophylaxis as applied to this great problem in preventive medicine.

Of these three methods the first two are therapeutic and the third is preventive, and as time goes on the preventive becomes the most important because, as I have indicated, mental disease, when finally developed, has already had several years of incubation, and it is obviously economically more worth while to try to prevent its origin than to cure it after it has become a serious problem. Particularly does the preventive problem loom as important when we learn, as we have in this country, that mental hospitals, or at least the number of beds in mental hospitals, are increasing more rapidly than the beds in all other types of hospitals combined. The significance, therefore, of mental hygiene as a public health problem is second, at the present time, to none other in medicine.

Finally, however, mental hygiene has developed a positive aspect which bids fair, as I see it, to be its outstanding feature in the course of its future development. The problems of contagious and infectious and epidemic diseases, whereas they have not all been solved, are all in process of solution along with many others, and the net result is that the average length of life has been very greatly increased. Obviously it becomes of increasing significance that these lives that are to continue for so many more years should afford some measure of comfort to their possessors and be of some social value. Mental hygiene is on this account alone more important than ever before, and its significance can be seen to be gradually changing from one of the simple prevention of mental disease, which is a negative program, to the positive attitude of endeavoring to find ways and means for people to live their lives at their best. Medicine has long enough maintained as ideals freedom from disease and the putting off of death. It is time that these were replaced by ideals of living, of actual creative accomplishment. The art of living must replace the avoidance of death as a prime objective, and if it ever does succeed in replacing it in any marked degree, it will be found that it has succeeded better in avoiding death than the old methods that had that particular objective as their principal goal. Health is a positive, not a negative concept.

This change in the significance of the desirability of health which the mental hygiene point of view has brought about is a matter of the utmost importance. It means no less than the pointing of all educational problems toward man's own welfare and best interests. It means the revaluation of biological laws in terms of their human significance, and the understanding of the significance of emergent evolution in its application to psychological functions. It involves almost a complete about-face from the educational methods of the last century and opens up untold vistas of possibilities for the future. The future of the evolution of man, it would seem, will be almost wholly confined to the evolution of his mind, and so far as we are able to determine from what we know of the mind and from our studies of the brain, the capacity for development of man's mind is to all intents and purposes infinite, and so with the new impetus from these new view-points of mental hygiene it is fair to assume that at some future date man may acquire as much knowledge of himself and control over himself as he has knowledge and control of his environment at the present time. A contemplation of such possibilities offers attractive opportunities for speculation which each may indulge according to his bent. But I for one verily believe that this century, which developed the world war catastrophe in its early years and led many to think that civilization itself was threatened, will ultimately prove to be the greatest of all centuries in accomplishments, particularly in the understanding of man by himself and in consequence a greater control of his destiny as it is worked out in the newly developed art of living.

I have indicated in the briefest possible way the simple beginnings of the mental hygiene movement and something of the course it has pursued in its development. It has finally come to branch out in so many directions that it is exceedingly difficult to gather them all into one all-enveloping concept. On the one hand, general medicine is appreciating more and more the psychological factors in disease. Some three years ago here in Washington at the meeting of the American Medical Association, the outstanding and most representative medical society in this country, its largest section on the practice of medicine devoted an entire afternoon to the subject of the emotional factors in disease, and I heard the internist and the cardiologist and other specialists tell of the large proportion of patients that they saw in their offices in whom they could find no disorder of the body. On the other hand, the social sciences are beginning to appreciate the psychological factors with which they have to deal. Social workers of various sorts are realizing more and more the significance of these factors. The criminologists are appreciating that radical differences are taking place in the concept of the nature and the significance of crime and of the best ways of treating criminals, and that these changes are taking place as a result of that sort of knowledge of the criminal that has been obtained through psychological means. The mental hygiene factor is evident in all directions, in medical problems and in social problems, not only in those that I have mentioned, but in many others. What are the mental hygiene factors, for example, that are involved in the multitudinous problems comprised in marital incompatibility, in venereal prophylaxis, in birth control,

in prostitution, in sterilization, in alcoholism and drug addiction, in the problems of old age and in chronic diseases such as tuberculosis and cancer, to cite only a few? What is the mental hygiene basis for such practical matters as the censorship of literature, of art, of the stage and of the movies? And in myriads of other directions how are we going to get any guidance unless we appreciate the fundamental psychological principles that lie at the basis of all these questions? And, finally, I am reminded that one of the most recent requests that has crossed my desk was a request to recommend a speaker to a distinguished group, meeting in the near future, who could discuss for them the bearings of mental hygiene on international relations. Surely the gamut is sufficiently extensive. And if, as the Greek philosopher said, "Man is the measure of all things," it might be added that that part of man which measures is his mind. If twenty-two years ago some one had said of Mr. Beers's prophecy of an international movement that it was impossible, every one would have believed him, but there is one factuality of the human mind to which the psychologists have paid very little attention, and that is the factuality of bringing to pass the impossible. In this particular instance, Mr. Beers's impossible prophecy has come to pass.

In this brief survey I have indicated some of the outstanding points in the development of the mental hygiene movement, how in the first instance the trials and tribulations of Mr. Beers were converted by the alchemy of his mind into the mental hygiene idea and how finally this has developed in every direction until it has reached international proportions. I have briefly indicated how the thought of the physician has been gradually changed by the introduction of the concept of mental health, and I would add only a few more words along this line in closing, for I believe that the most significant change that mental hygiene is going to effect in the future will be a change in our concept of values as applied to human beings. I have indicated that the highest ideals that medicine had reached in the last century were the prevention of disease and the avoidance of death. These ideals, when applied in the mental field, were expressed in the well-known dictum, "A sound mind in a sound body." If, however, as I believe, living in order to avoid dying presents very little that is either worth while or stimulating as an ideal, so the concept of the sound mind in the sound body falls equally short of the truth, and in the same, namely, a negative, direction. The thought that I would like you to take away from the few words that I have said is that mental hygiene presents a positive program for life well lived, for mental health because of its values and not because of what it avoids. The value of life is measured by what we become, and so by the nature of the influences we radiate in our living. Life's values, from the standpoint of mental health, are not expressed in terms of the chemistry of nutrition or the integrity of the heart muscle or of any organ, but in terms of character, of man as a social being, of those effects which he produces on those about him, the enthusiasms he stimulates, that go reverberating down the ages translated by the personalities that trace back to the original source. This is a tangible form of immortality toward which every one may strive with some show of success, and in the striving get out of life the most there is in it for him. Perhaps I can express this ideal no better than in the words of Plato, who said over two thousand years ago: "My belief is, not that a good body will of its own excellence make the soul good, but on the contrary that a good soul will by its excellence render the body as perfect as it can be."

PERIODICALS FOR ELECTRICAL ENGINEERS

By Professor J. K. McNEELY AND C. D. CROSNO

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THREE items of importance in the qualifications of a department for granting the degree of doctor of philosophy are a competent staff, adequate library facilities and funds and equipment. The lack of any one of the three will seriously interfere with thorough research work and render futile the research work of the staff and of the advanced graduate students.

This paper is concerned with the library facilities. It was thought desirable that the research publications at Iowa State College be checked over to ascertain the deficiencies existing. The question at once arose as to the standard to be used in making a list of the periodicals which should be available.

It was found that similar studies had already been made in the fields of chemistry[1] and mathematics.[2]

After some study, it was decided to count the references to periodicals in the following journals for the period from January, 1925, to June, 1929, inclusive.

[1] P. L. K. Gross and E. M. Gross, "College Libraries and Chemical Education," SCIENCE, 66: 385, 1927.

[2] Edward S. Allen, "Periodicals for Mathematicians," SCIENCE, 70: 592, 1929.

Table I gives the number of references in each of these journals for this period.

TABLE I

Seven Journals Used

	Number of references
American Institute of Electrical Engineers (*Transactions*)	2,994
Archiv für Elektrotechnik	2,122
Electric Journal	187
Elektrotechnische Zeitschrift	4,602
Franklin Institute, *Journal*	446
Institution of Electrical Engineers, *Journal*	2,174
Revue Générale de l'Electricité	5,466
Total	17,991

It will be noted that the list contains three American, one English, two German publications, and one French publication. The result is that the English language publications predominate, but it is assumed that such should be the case for American libraries.

TABLE II

References Counted in the *Transactions* of the American Institute of Electrical Engineers, January, 1925, to September, 1929

	Number of references	Per cent.
A. I. E. E. *Trans.*	845	28.22
Annalen der Physik	44	1.47
Archiv für Electrotechnik	69	2.30
Bell System Technical Journal	48	1.60
Electrician	49	1.63
Electric Journal	131	4.37
Electrical Review	36	1.20
Electrical World	228	7.61
Elektrotechnische Zeitschrift	59	1.97
Elektrotechnik und Maschinenbau	35	1.16
Engineering (London)	39	1.30
Franklin Institute, *Journal*	42	1.40
General Electric Review	152	5.07
Institution of Electrical Engineers, *Journal*	65	2.27
Philosophical Magazine	44	1.47
Physical Review	82	2.73
Power	57	1.90
Power Plant Engineering	32	1.06
Railway Electrical Engineer	82	2.73
Royal Society of London, *Proceedings*	35	1.16
Miscellaneous	820	27.38
Total	2,994	100.00

Some diversity of subject-matter is obtained by the selection of these particular publications, including the American, English, German and French journals.

The question of including the references to other articles in the same publication (for example, references to articles in the *Transactions* of the American Institute of Electrical Engineers, when counting references therein) has been discussed by Professor Allen in his study in the field of mathematics. It seemed desirable in the present paper to include such references with the others. The journals selected to furnish the references were the more important ones in the field. There seemed, therefore, to be no good reason for omitting references to themselves although their number might be somewhat excessive.

Also it seemed logical to reduce the references to a percentage basis so that equal weight might be given to each of the seven journals used. Table II shows the proportions of the various references listed from the *Transactions* of the American Institute of Electrical Engineers. Similar tables were made for the other six journals but have not been included in this paper.

The individual percentages from the seven tables were divided by seven and combined in Table III, giving the figures as percentages of the total. Table III shows the reference periodicals arranged in the order of their importance as determined by the method here described.

TABLE III

Reference Periodicals Arranged in the Order of their Importance

		Per cents. of total references
1.	American Institute of Electrical Engineers, *Transactions*	10.851
2.	*Elektrotechnische Zeitschrift*	7.925
3.	*Revue Général Electricité*	7.591
4.	*Electric Journal*	6.616
5.	*Archiv für Elektrotechnik*	5.843
6.	Institution of Electrical Engineers, *Journal*	3.888
7.	*Physical Review*	3.729
8.	*Philosophical Magazine*	3.157
9.	*Annalen der Physik*	3.017
10.	*Electrical World*	1.909
11.	Royal Society of London, *Proceedings*	1.822
12.	*Electrician* (London)	1.474
13.	*Electric Railway Journal*	1.228
14.	Franklin Institute, *Journal*	1.200
15.	Académie des Sciences, *Comptes Rendus*	1.158
16.	*General Electric Review*	1.129
17.	*Elektrotechnik und Maschinenbau*	.997
18.	*Zeitschrift für Physik*	.970

TABLE III—*Continued*

	Per cents. of total references
19. *Zeitschrift für physikalische Chemie, Stochiometrie und Verwandtschaftslehre*	.940
20. Institute of Radio Engineers, *Proceedings*	.867
21. Société Française des Electriciens, *Bulletin*	.724
22. Physical Society of London, *Proceedings*	.719
23. American Chemical Society, *Journal*	.708
24. *Bell System Technical Journal*	.664
25. National Electric Light Association, *Proceedings*	.607
26. *Electrical Review*	.593
27. *Physikalische Zeitschrift*	.521
28. *Power Plant Engineering*	.420
29. *Elektrizitätswirtschaft Mitteilungen*	.405
30. *Railway Electrical Engineer*	.389
31. *Elektrizitäts Verwertung*	.318
32. *Zeitschrift für technische Physik*	.290
33. *Power*	.275
34. *Engineer*	.231
35. *Electric Light and Power*	.231
36. American Electrochemical Society, *Transactions*	.231
37. *Siemens wirtschaftliche Mitteilungen*	.217
38. *Zeitschrift für Instrumentenkunde*	.202
39. *World Power*	.202
40. *Journal de Physique et le Radium*	.188
41. Optical Society of America, *Journal*	.188
42. *Engineering* (London)	.188
43. Société Française de Physique, *Bulletin*	.173
44. *Zeitschrift für Elektrochemie und Angewandte physikalische Chemie*	.159
45. *Physico-Mathematical Society of Japan*	.159
46. *Journal de Physique, Chimie et Histoire Naturelle Elémentaires*	.159
47. *American Journal of Roentgenology*	.159
48. Union des Syndicates de l'Electricité, bi-mensuel *Bulletin*	.145
49. Verein Deutscher Ingenieure, *Zeitschrift*	.145
50. Association Suisse des Electriciens, *Bulletin*	.145
A. Miscellaneous	23.934
Total	100.000

It will be noticed that about 24 per cent. of the references are included under the heading Miscellaneous. This is due to the method of including in the list of references, for each of the seven journals, only those appearing to a total of more than 1 per cent. of the number of references in that journal. The balance were grouped under the head Miscellaneous. Since these seven groups were added, the Miscellaneous per cent. is higher than it should be.

The publications included in Table III are those containing more than 1 per cent. of the references found in any one of the seven journals. In some cases a particular publication would total more than 1 per cent. on two or three lists and fractions of a per cent. on the other four or five. The fractions were included under the heading Miscellaneous. Had these been distributed, the effect on the total per cent. for each publication would have been slight. The combined effect on the Miscellaneous total of a number of such cases would have been greater.

For example, references to *Annalen der Physik* are more than 1 per cent. of the references listed from each of the following journals, the *Transactions* of the American Institute of Electrical Engineers, the *Archiv für Elektrotechnik* and the *Journal* of the Franklin Institute. References to *Annalen der Physik* are 0.75 per cent. of the total in *Revue Générale de l'Electricité,* 0.263 per cent. of the total in *Journal* of the Institution of Electrical Engineers, 0.50 per cent. of the total in the *Elektrotechnische Zeitschrift* and are not found in the *Electric Journal.* Since these are each less than 1 per cent., they are included under Miscellaneous, yet if they had been added to those found for the first-mentioned journals, the total Miscellaneous per cent. would have been reduced 0.22 per cent. The effect on the total for *Annalen der Physik* is negligible. Although the change in the Miscellaneous per cent. would be large if such a correction were made for all similar cases, the additional work could not be justified, since the relative order of the references would be little changed.

Since this list was made up from the standpoint of electrical engineering only, it follows that a library serving other branches of engineering, physics and chemistry should make up a composite list from similar lists for each.

It should be understood that lists such as those discussed in this paper are based upon the assumptions made, and that other investigators would probably obtain somewhat different results if permitted to make the assumptions which seemed most logical to them.

However, this problem is similar to many others in engineering. The best that can be done is to start out with the best assumptions possible and derive results which are more accurate than could be obtained by assuming the final result.

The assumptions in this case are: (1) the value of a periodical to professional workers is in direct proportion to the number of times it is cited as a reference in technical articles in the field in question;

(2) that the seven journals for the period from January, 1925, to June, 1929, give a correct view of the relative use of technical periodicals in general by American electrical engineering students, faculty and research workers; (3) that the seven periodicals used should be weighted equally.

The results obtained in this survey have cost no little effort upon the part of those interested in graduate work at this institution. Other institutions doubtless will appreciate such a list of periodicals in checking over their holdings. It is with this in mind that this paper is presented for publication.

SCIENTIFIC EVENTS

THE RAYLEIGH COLLECTION AT THE SOUTH KENSINGTON MUSEUM[1]

AMONG recent additions to the Science Museum, South Kensington, is a most interesting collection of apparatus used by the late Lord Rayleigh in the course of his scientific research. On the occasion of the unfortunate fire, last year, at Lord Rayleigh's home at Terling, Essex, a considerable quantity of apparatus was destroyed, but the historical apparatus was fortunately undamaged and the bulk of it has been generously given by the present Lord Rayleigh to the Science Museum, where it should prove a continual source of interest and inspiration to professional and amateur scientific workers alike. It is scarcely necessary to remind readers of *Nature* of the extent and importance of the late Lord Rayleigh's contributions to science. During a period of more than fifty years he published no fewer than 446 papers, every one of which made a distinct addition to our knowledge of the subject and was characterized by that lucidity and elegance of expression for which its author was renowned.

On viewing this collection, one is struck very forcibly—as were visitors to the laboratory at Terling—by the extraordinary simplicity of the bulk of the apparatus. The ability to attain results of the highest accuracy and importance by the aid of odd bits of wood, glass tubing, wire and sealing-wax was undoubtedly bound up with Rayleigh's unerring instinct in discriminating between the essential and the non-essential. It is doubtless true that some branches of modern physical research can not profitably be pursued without the use of expensive apparatus. At the same time, many workers who are apt to grow despondent after a perusal of the price-lists of the scientific instrument makers should find a tonic in the Rayleigh collection, which also serves as a salutary reminder that the man is more important than his tools.

The present collection is thoroughly representative of the vast field which Lord Rayleigh covered, and is exhibited in six cases, two dealing with acoustics, while the remainder come under the headings of optics, magnetism and electricity, argon, and miscellaneous. It is impossible in a short notice to deal adequately with the whole of the exhibits, but a few representative examples may perhaps be mentioned. The acoustics section includes apparatus used in experiments on reflection and interference and on the intensity of aerial vibrations; also the apparatus by means of which it was demonstrated that our lateral perception of the direction of a sound depends upon the phase-difference at the two ears. One of the most important exhibits in the optical section is the apparatus used for the determination of the constant of the magnetic rotation of light in carbon disulphide, while there is also a reminder that, so early as the year 1902, Rayleigh made an attempt to detect motion through the ether. Prominent in the electrical section will be found apparatus for determining the laws of resistance of periodic currents. The argon collection gives an excellent idea of the course taken in that classical series of investigations extending from 1892 to 1895 in the latter part of which Sir William Ramsay collaborated, while under "Miscellaneous" the chief exhibits deal with capillarity, fluid motion, and cognate problems. Every piece of apparatus has been provided with a full explanatory label giving references to the original source and to the "Collected Scientific Papers," and public lectures on the exhibits will be given from time to time.

[1] From *Nature*.

THE NEW SCIENTIFIC LABORATORIES AT THE UNIVERSITY OF CHICAGO

Two new science buildings, each believed to be the finest of its kind in the United States, were opened recently at the University of Chicago for the first time to accommodate summer quarter classes. The recently completed buildings are the Bernard A. Eckhart Hall of Mathematics, Mathematical Astronomy and Physics and the new Botanical Research Laboratory.

Seventeen classes in mathematics and astronomy moved into the Eckhart building, the erection of which was made possible by a gift of $710,000 from Mr. Bernard A. Eckhart. Adjoining the older Ryerson Physical Laboratory on the east, the new structure rises to four floors along University Avenue on the Main Quadrangle.

Eckhart Hall, the work of Charles Z. Klauder, Philadelphia architect, is said to be one of the finest

of the university's Gothic buildings. Basement and first floor are devoted to thirty-eight research rooms for the department of physics, part of which will be used for the work of Professors Arthur H. Compton and Arthur J. Dempster and their graduate students. Professor Michelson will retain his laboratory in Ryerson, where he has worked for many years.

The upper floors will be used by mathematicians and astronomers, departments which for the first time will have adequate facilities. In addition to nine classrooms there are thirty-nine offices for the faculty, fellows and graduate students of those departments. Other features of Eckhart Hall are an assembly room seating 240 and a library with facilities for 88 readers and 50,000 volumes.

Three laboratory classes in plant physiology now occupy the new Botanical Laboratory.

There are no classrooms or library in the laboratory, which adjoins the group of greenhouses finished last year. It is to be devoted to research in plant physiology and plant pathology.

Features of the new buildings are its biochemical and biophysical laboratories, where studies such as those on the effect of X-rays on plants will be prosecuted. Constant temperature rooms, where cold as low as 40 degrees below zero can be maintained; inoculation quarters, in which the entire room may be given a shower or steam bath, so that plant disease germs may be transferred without contamination; animal quarters for the study of the plant germs they carry; rooms which reproduce the conditions under which fruits and vegetables are moved; X-ray and seed-germination rooms are also features of the laboratory.

SUMMER MEETING OF THE BOTANICAL SOCIETY OF AMERICA

THE Summer Meeting of the Botanical Society of America will be held in August at the Puget Sound Biological Station at Friday Harbor, Washington.

The local committee, of which Professor T. C. Frye is chairman, has arranged a tentative program in which indoor discussions and a variety of trips and excursions to points of varied interest find place. Unusually favorable tide conditions will offer an excellent opportunity to study the wonderful algal flora of these waters. Many will appreciate the chance to see a sample of the great forest growth of the northwest.

PROGRAM

August 19—Tuesday

Afternoon—Registration at the station office.

8 P. M. Address of welcome.
Lecture on "The Geology of the San Juan Islands."

August 20—Wednesday

8:30 A. M. Marine dredging for algae at Canoe Island.
8:30 A. M. Auto trip to Castle Point for wind effects, forest and prairie gradation.
8:30 A. M. Trip to Douglas Fir Forest.
1:00 P. M. Dr. E. J. Lund will demonstrate electrical polarity in the Douglas Fir.

August 21—Thursday

8:30 A. M. Visit in row boats to Nereocystis beds.
8:30 A. M. Marine dredging and marine ecology.
8:30 A. M. Trip to fields.
2:00 P. M. Discussion—Meetings of groups interested in algae, ecology and mycology.

August 22—Friday

All sections will participate in an early morning drive to False Bay, where tide recedes half a mile. Return to station for lunch.

Tents, meal accommodations, boats and other facilities of the station will be at the disposal of members of the society and guests. At this meeting the spirit of informality will prevail, as at the earlier summer meetings, and all will find much to enjoy in the friendly give-and-take of the occasion. Parking space for automobiles and tenting grounds for those traveling in this way will be available.

RODNEY H. TRUE,
Vice-president for the Committee on Arrangements

FIRST AWARDS OF THE PACK FOREST EDUCATION BOARD

MAKING its first award of fellowships ranging up to $1,800 a year for training leaders in forestry, the Charles Lathrop Pack Forest Education Board has announced its selection of five Americans and one Canadian for the year 1930. The winning candidates were chosen from about ninety contestants. The fellowships were established to encourage men of unusual intellectual and personal qualities to obtain training that will equip them for important work, either in the general practice of forestry, in the forest industries, in the teaching of forestry, in forest research, or in the development of public forest policy. The successful candidates are:

James Lindsay Alexander, assistant professor, College of Forestry, University of Washington. To make an investigation of forest survey methods with the object of developing the needed precision with the least cost at the University of Toronto, the University of Washington and in the forests of the eastern and western United States.

Ralph Caird, graduate student, University of Chicago. To make a general study of forestry at the School of Forestry and Conservation of the University of Michigan, and to do advanced work in tree physiology and pathology.

Bernard Frank, assistant forest economist, U. S. Forest Service, Washington, D. C. To make studies at the University of Wisconsin and field investigations in the Lake States of land classification methods and land utilization technique especially as applied to forest lands, together with the preparation of a program of land use for a specific region.

George Ritchie Lane, forester in charge of reforestation, Canada Power and Paper Corporation, Grand' Mere, Province of Quebec, Canada. To make field investigations of the planting, growth and yield of pulpwood species in the Maritime Provinces of Canada, in the hope of reducing the costs of reforestation.

Raymond Frank Taylor, forest examiner, U. S. Forest Service, Juneau, Alaska. To make studies of the silvicultural management of coniferous forests at the School of Forestry, Yale University, supplemented by field work in Washington and Alaska.

John Burton Woods, forester, Long-Bell Lumber Company, Longview, Washington. To make field investigations and to gather material on forestry as practiced in private timberlands and to write a book on the application of forestry to private lands.

During the coming autumn the Forest Education Board will receive applications for the award of approximately eight additional fellowships for 1931–32.

APPOINTMENTS IN THE U. S. GEOLOGICAL SURVEY

R. C. WELLS has been appointed chief chemist in charge of the Division of Chemistry in the U. S. Geological Survey, and George Steiger, former chief, will return to studies in chemical and spectroscopic analysis.

W. D. Johnston and F. G. Wells have been transferred from the Water Resources Branch to the Geologic Branch and assigned to field work.

Eugene Callaghan, Edwin B. Eckel, Charles L. Gazin, E. N. Goddard, Charles B. Hunt, Bernard N. Moore, Watson H. Monroe, Charles F. Park, Jr., and Aaron G. Waters have been appointed junior geologists, and Lloyd G. Henbest, J. Harlan Johnson, Maxwell M. Knechtel, Albert H. Koschmann, Robt. E. Landon, Charles B. Read, Philip J. Shenon, Ralph B. Stewart and J. Steele Williams, assistant geologists in the Geologic Branch, U. S. Geological Survey.

Richard C. Cady and Stanley W. Lohman have been appointed junior geologists in the Water Resources Branch.

Stanly Cathcart, formerly connected with the Geological Survey, was reinstated as geologist in the Conservation Branch, but has recently joined the Pennsylvania Geological Survey staff.

Ralph W. Richards has been reinstated as geologist in the Geologic Branch.

Wendell P. Woodring, for the past few years on the staff of the California Institute of Technology, resumed full time service with the U. S. Geological Survey on July 1, 1930.

SCIENTIFIC NOTES AND NEWS

THE first meeting of the National Academy of Sciences to be held west of Wisconsin will take place from September 18 to 23, opening at the University of California, moving to Stanford University on the third day, and to the California Institute of Technology in Pasadena for the following two days. Arrangements for the meeting are in the hands of a committee including Director Robert G. Aitken, of the Lick Observatory, Professor A. O. Leuschner and Professor William C. Bray, chairman, all of the University of California; Professor W. F. Durand, of Stanford University; Robert O. Schad, of the Huntington Library; Dr. F. H. Seares, of the Mount Wilson Observatory, and Professor Richard C. Tolman, of the California Institute of Technology. Addresses of welcome at the three institutions respectively will be made by President Robert Gordon Sproul, of the University of California; Acting President Robert E. Swain, of Stanford University, and Dr. Robert A. Millikan, chairman of the executive council of the California Institute of Technology. Dr. Isaiah Bowman, of the American Geographical Society, will give an address on the opening day of the session, at 8 p. m. in Wheeler Auditorium, University of California.

BARON GERARD JAKOB DE GEER, Stockholm, and Professor Tullio Levi-Civita, Rome, have been elected foreign members of the Royal Society, London.

WE learn from *Nature* that at a meeting of the Royal Society of Edinburgh, held on July 7, the following were elected honorary fellows: *British Honorary Fellows*—Sir Arthur Stanley Eddington; Sir William Bate Hardy; Sir Arthur Keith; Professor J. E. Marr; Professor R. Robinson, Dr. D. H. Scott; *Foreign Honorary Fellows*—Professor V. F. K. Bjerknes, Bergen; Professor W. B. Cannon, Cambridge; Professor M. Caullery, Paris; Professor G. Fano, Rome; Professor E. H. O. Stensiö, Stockholm.

PROFESSOR CHARLES MORSE ALLEN, emeritus head of the department of chemistry at Pratt Institute and son of Dr. Charles Frederic Allen, the first president of the University of Maine, received the degree of doctor of laws at the fifty-ninth commencement of the university.

AN honorary degree of doctor of science has been

conferred by Wabash College upon Professor Samuel J. Record, research associate in wood technology on the botanical staff at Field Museum of Natural History.

ON Wednesday evening, July 9, about forty colleagues and friends of Professor Edwin D. Starbuck, head of the department of philosophy and director of the Institute of Character Research at the University of Iowa, tendered him a fellowship dinner in the Memorial Union. A number of addresses were given in appreciation of his twenty-four years of service at the University of Iowa on the eve of his departure for the University of Southern California, where he has accepted a position as professor of philosophy. A leather bound volume of personal letters addressed to him by his colleagues was presented.

DR. CLARA STOLTENBERG, professor of anatomy at Stanford University, was the guest of honor recently at a dinner given in Stanford Union by a group of her friends. The affair was in the nature of a farewell to Dr. Stoltenberg, who will retire at the close of the present quarter, after having been a member of the faculty since 1896. Tributes were paid to her by Dr. Thomas M. Williams, '97, and by Professors Isabel McCracken, '04, Frank M. MacFarland, '93, and Oliver P. Jenkins. Approximately ninety friends and colleagues were present.

DR. A. R. JOHNSTON, research associate in the department of physiology of the University of Cincinnati, has been granted $1,000 by the committee on scientific research of the American Medical Association to further his studies of the toxic action of the amines as found in nature or produced by disease.

DR. JESSE H. WHITE, head of the department of psychology at the University of Pittsburgh, has been elected president of James Millikin University at Decatur, Illinois.

AT the University of Minnesota, Dr. D. E. Minnich has been appointed chairman of the department of zoology, succeeding Dr. W. A. Riley, who has resigned to become chief of the division of entomology and economic zoology, following Dr. R. N. Chapman. Dr. Riley will continue his professorship in the department of zoology.

DR. MARY ISABEL MCCRACKEN has been promoted to a full professorship of zoology at Stanford University.

DR. H. W. GILLETT, director of the Battelle Memorial Institute, Columbus, Ohio, announces the appointment of Mr. Byron M. Bird, of the U. S. Bureau of Mines, as chief concentration engineer. Mr. Bird joined the staff of the institute on July 1 and assumes responsibility for research work on both ore dressing and coal preparation under the direction of Mr. Clyde E. Williams, assistant director.

SIR FREDERIC GEORGE KENYON, since 1909 director and principal librarian of the British Museum, will retire at the end of this year.

PROFESSOR E. J. GARWOOD, representing the London Geological Society, addressed the Geological Society of France during its centenary celebrations in the Sorbonne on June 30.

AT the University of North Carolina, Dr. C. Dale Beers, associate professor of zoology, has been granted a year's leave of absence, and Dr. J. M. Valentine, acting-assistant professor of zoology during the current absence in Italy of Professor H. V. Wilson, has been reappointed for the coming year. Dr. Beers will spend the greater part of his year's leave as guest investigator in the Kaiser Wilhelm Institute for Biology, at Berlin-Dahlem, where he will be associated with Professor Max Hartmann.

THE Rockefeller Institute for Medical Research will be represented abroad this summer at several international scientific conferences. Dr. Alexis Carrel is to report on new techniques in cytology at the Second International Congress of Cytology in Amsterdam. Dr. Karl Landsteiner and Dr. Thomas M. Rivers are to report at the International Microbiological Congress in Paris on blood groups and filterable viruses, respectively. Dr. Peter K. Olitsky is to report on *Bacterium granulosis* (Noguchi) at the meeting of the International Union against Trachoma to be held under the auspices of the Health Section of the League of Nations in Geneva. Dr. Wade H. Brown is to report on experimental syphilis at the Eighth International Congress of Dermatology and Syphilology in Copenhagen. Dr. Ralph W. G. Wyckoff will attend the meeting of the International Committee to Standardize Nomenclature and to Prepare Tables in Crystal Analysis, to be held in Zürich.

DR. LEO LOEB, of Washington University, St. Louis, is spending the summer in study and research at the Scripps Institution of Oceanography at La Jolla.

MR. M. W. STIRLING, chief of the Bureau of Ethnology, is making an archeological reconnaissance in Nevada and Texas.

DR. WALDO L. SCHMITT, curator of the Division of Marine Invertebrates, U. S. National Museum, left on July 5 to spend six weeks at the Carnegie Marine Laboratory at Tortugas, Florida. He will continue a study of crustacean contents of fish stomachs which he is making in collaboration with Dr. William H. Longley, of Goucher College, director of the Carnegie Laboratory.

THE second radio talk in the series presented by the

American Association for the Advancement of Science in cooperation with the National Broadcasting Company will be given on Monday, July 28, at 7:00 P. M., eastern standard time. The subject will be "Notes from the last Cruise of the *Carnegie*," and the speaker will be Mr. O. W. Torreson, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, who was navigator and executive officer of the *Carnegie*. Mr. Torreson will describe for the first time some of the new contributions to knowledge resulting from the work of the *Carnegie* and explain their importance to the world at large. The third talk in the series will be on the investigations being undertaken this summer in the Hawaiian Islands by the U. S. Bureau of Fisheries. It will include the first announcement of the results of these investigations. This talk will be given, at a date to be announced later, toward the end of September, and the speaker will be Dr. Paul S. Galtsoff, of the Bureau of Fisheries.

FOUR members of the faculty of the University of Minnesota were honored by the selection of their symposium, "The Measurement of Man" (University of Minnesota Press), a study in biometrics, as the August "book of the month" by the Scientific Book Club. The authors were the late Dr. J. Arthur Harris, who was head of the department of botany; Dr. Clarence M. Jackson, director of the Institute of Anatomy; Dr. Richard E. Scammon, professor of anatomy, and Dr. Donald G. Paterson, professor of psychology—all of the University of Minnesota. The papers presented in this symposium were originally lectures delivered at the university under the auspices of Sigma Xi. Dr. Harris contributed "The Measurement of Man in the Mass"; Dr. Jackson, "Normal and Abnormal Human Types"; Dr. Scammon, "The Measurement of the Body in Childhood," and Dr. Paterson, "Personality and Physique." The book will be published on August 12.

LEAVE of absence, according to *The Experiment Station Record*, has been granted by the University of California to Dr. W. P. Kelley, professor of agricultural chemistry and agricultural chemist, to undertake a survey sponsored by the American Society of Agronomy in cooperation with the university as to the present status of nitrogen fertilizer research in the United States and Europe; Dr. W. L. Howard, director of the Davis branch of the College of Agriculture, for six months to be spent in study and travel in Europe, during which time T. F. Tavernetti, assistant to the dean of the College of Agriculture, will serve as acting director at Davis; F. T. Bioletti, head of the division of viticulture and fruit products, in connection with further exploration studies in the Mediterranean region, mainly as related to the horticultural needs of the southwestern United States and in cooperation with the U. S. D. A. Bureau of Plant Industry; E. B. Babcock, head of the division of genetics, for four months for travel in foreign countries for the purpose of collecting specimens, and Asher Hobson, professor of agricultural economics in the Giannini Foundation of Agricultural Economics, to enable him to organize and develop a foreign agricultural information service for the U. S. D. A. Bureau of Agricultural Economics and the Federal Farm Board.

DELEGATES to represent the United States at the fourth World's Poultry Congress, to be held in London this month, sailed from New York on July 9. These include W. F. Priebe, Chicago; Mrs. Lucy B. Garber, Enid, Okla.; C. I. Bashore, Silver Lake, Ind.; Gordon M. Curtis, Dayton, Ohio; Dr. Leslie E. Card, Urbana, Ill.; Harry R. Lewis, Greenwich, R. I.; Harold A. Nourse, St. Paul, Minn.; D. Lincoln Orr, Cornwall, N. Y.; Arthur M. Peine, Manhattan, Kans.; F. H. Cockell, Milwaukee, Ore.; W. A. Scheit, Syracuse, N. Y.; L. B. Kilbourne, Chicago; Dr. John R. Mohler, Department of Agriculture; Dr. Morley A. Jull, Department of Agriculture; R. R. Slocum, Department of Agriculture, and S. D. Sanders, Seattle, Wash. The resolution authorizing the appointment of these delegates also provides for an authorization of $15,000 for their expenses. The government had previously provided the sum of $25,000 to cover the cost of a national exhibit.

A NOTE concerning the dedication ceremonies of the new medical building of the University of Brussels printed in the issue of SCIENCE for July 4 contains several inaccuracies. It should have read: The buildings were erected jointly by funds provided by the Rockefeller Foundation and the city of Brussels. The degree of *doctor honoris causa* was conferred on Dr. Simon Flexner, director of the Rockefeller Institute, and on Dr. Abraham Flexner, formerly of the General Education Board, who was recently elected director of the newly established Institute for Advanced Study at Newark, New Jersey.

A CONTRACT, representing an expenditure of more than $291,000 for 5,735 milligrams of radium and accessory equipment to be delivered to the State Institute for the Study of Malignant Diseases at Buffalo, was recently signed by Dr. Thomas Parran, Jr., state commissioner of health. Certificates of the U. S. Bureau of Standards attesting the quantity of radium element will be delivered with the material. The purchase was made possible by an appropriation of $300,000 for the purpose at the last session of the state legislature. With the acquisition of this additional radium, the institute, so far as known, will possess the largest single supply in the world.

THE will of the late Elmer A. Sperry, the distinguished engineer, who died in Brooklyn last month, creates a trust fund of $1,000,000, the income from which is to go to the Young Men's Christian Association. Half the income will go toward the seventy-fifth anniversary drive of the Brooklyn and Queens Y. M. C. A. for ten years, and the other half will be applied on the building fund of the Flatbush Y. M. C. A. After ten years the income will be used in any way that the national board of the organization may designate, although Mr. Sperry included in his will a wish that special preference always be given to the Flatbush branch.

THE British Minister of Health, Mr. Arthur Greenwood, after consultation with the London County Council and the senate of the University of London, has appointed a Provisional Organization Committee to proceed with the action necessary to secure the establishment of the British Postgraduate Hospital and Medical School. The terms of reference of the committee are to consider and report, in pursuance of the statement made by the Minister of Health in the House of Commons on April 9, upon (1) the action requisite to lead up to the planning and construction of the Medical School and (2) the form of government appropriate to the Hospital and Medical School, with special reference to the position of the London County Council as the local authority responsible for the hospital, and to the position of the University of London in relation to the school. The chairman of the committee is the Rt. Hon. Viscount Chelmsford. The Ministry of Health will be represented by Sir George Newman, chief medical officer, and Mr. M. Heseltine, assistant secretary. The London County Council will be represented by Miss F. Barrie Lambert, Sir William Ray, Mr. Angus N. Scott and Mr. L. Silkin. The University of London will be represented by the Rev. J. Scott Lidgett, the vice-chancellor elect; Mr. Sidney L. Loney, the chairman of convocation and deputy chairman of the court; Mr. H. L. Eason, superintendent and senior ophthalmic surgeon, Guy's Hospital, and Dr. Edwin Deller, principal.

DISCUSSION

THE MAGNETIC POLES OF THE EARTH AND THE BIRTH OF THE MOON

GEOPHYSICISTS recognize many structural asymmetries of the earth, such as the existence of continents of land and an elliptical figure of an equatorial sea-level section. The inequality of the two axes of this ellipse is of the order of one kilometer, the major axis terminating in central Africa and in Hawaii, the minor axis in Sumatra and the Andes.[1]

A remarkable asymmetry exists in the longitude of the earth's magnetic poles, which are at present in 96° west and 155° east longitudes. They are, therefore, only 109° apart, and their longitudes mark out roughly the average boundaries of the Pacific Ocean, the vast basin of which has many "deeps" and is enclosed by a giant circlet of extinct and active volcanoes. If this basin is the birthplace of the moon, it does not seem unreasonable to expect that enough of the heavier, deep-lying magnetic elements in the earth may have been torn along, placenta-wise, on that natal occasion to actually fix the magnetic poles of the earth in these regions. Perhaps it would be better to say that when the lunar material departed, a shift in the distribution of magnetic materials within the remaining mass took place toward the Pacific basin.

While it seems difficult to believe that the readjustment of the earth to approximately spherical form after such an enormous loss could leave anything fixed, other asymmetric vestiges of diastrophic changes in the earth during its long history have survived so that the one discussed here may not be ruled out *a priori*.

Attention may have been called to this bit of circumstantial evidence that the moon was born of the earth, but I have not found any mention of it in a casual perusal of several recent books on geology and geophysics.

OLIVER JUSTIN LEE

DEARBORN OBSERVATORY,
EVANSTON, ILLINOIS

[1] See Jeffreys, "The Earth," p. 222.

EFFECT OF WATER ON TRIBOELECTRIC LUMINESCENCE WITH MERCURY IN GLASS

THOSE who have investigated the phenomenon of the faint flashing to be observed when mercury moves over a glass surface in a vessel containing gas at low pressure seem to have concluded quite unanimously that the presence of water destroys the effect.

The authors have determined that this statement is subject to a certain limitation. For Pyrex glass, at any event, and presumably for other glasses, the presence of water vapor makes no difference unless saturation is approached.

The observations resulted from watching the operation of a Töpler pump in a darkened room. In the absence of water vapor, the fall of mercury in the pump was accompanied by periodic flashing during the entire time of the down-stroke. When, however, water vapor at about half saturation pressure was admitted, the up-stroke of the pump resulted in

condensation of water on the glass walls after the mercury had more than half filled the pump, and practically no water was carried over by the mercury at the end of the stroke; then, during the fall of the mercury, no flashing was to be observed at first, but it commenced abruptly and continued after the mercury had come about halfway down. With varying original partial pressures of water vapor, the point at which flashing began differed; but in each instance there was complete absence of flashing while the space above the mercury was saturated, and flashing occurred as in a perfectly dry pump as soon as the space was less than saturated.

These results seem reasonable enough. No considerable potential difference between the mercury and the uncovered glass above it can build up, by separation of the glass and mercury, as long as a slightly conducting film of liquid water is on the glass; but as soon as the liquid film has evaporated, separation of the glass and mercury, as the latter falls in the pump, gives increasing potential difference until discharge through the space above the mercury, with an accompanying flash, occurs; and unsaturated water vapor does not interfere with the process.

Thomas S. Logan
Roger K. Taylor

Chemical Laboratory,
Johns Hopkins University

GAS DISCHARGE WAVE-LENGTH LIST IN THE EXTREME ULTRA-VIOLET

We have prepared a list, arranged in order of wave-length, of the published lines in the extreme ultra-violet (λ 2500 to λ 100) arising from discharges in gases. The elements included are hydrogen, helium, carbon, nitrogen, oxygen, neon, sodium, silicon, argon and mercury. Thanks to support from the Carnegie Institution of Washington it has been possible to publish a limited mimeographed edition of the list, copies of which have been sent to a few spectroscopists to whom we thought it might be of particular use. We should be glad to give copies to any others who may write requesting them.

Janet M. MacInnes
Joseph C. Boyce

Palmer Physical Laboratory,
Princeton University

MORE ABOUT A UNIFORM BIBLIOGRAPHIC SYSTEM

In the issue of Science for January 10, 1930, Dr. M. C. Merrill, editor of the *Journal of Agricultural Research*, calls attention to certain alleged disadvantages of the name-date system of presenting literature citations. He involves the name-date system in an instance of *reductio ad absurdum* by citing a case where nineteen literature citations were noted at one point. The case used to illustrate the alleged absurdity is rather an exceptional one. An inspection of current articles in a variety of scientific journals will show that the total number of literature citations in the text of papers which refer to a large number of papers is comparatively small. A survey of over 5,100 citations has shown that over 95 per cent. referred to only one article in the bibliography; over 3 per cent. referred to two articles; more than 1 per cent. to three articles, while .31 per cent of them referred to four articles. This makes the proverbial 99.4 per cent. of these citations which referred to one, two or three articles, or 99.9 per cent. of the citations referring to five articles or less. One citation was found in the *Journal of Agricultural Research* which referred to seventeen different articles. This calculates to .01946 per cent. Dr. Merrill calls attention to one other such exception. No others were found containing more than seven citations at one point. It might also be mentioned that, of the ten lines used by Dr. Merrill in his elaborated citation in Science, nearly three are given over to comments not usually incorporated in such citations.

The use of the letters *a, b, c,* etc., to differentiate between papers published the same year by one author is no more cumbersome than their use for insertion of additional references into a completed manuscript at the galley-proof or other stage. The writer prefers an alphabetical list of references in practically all instances.

Attention is called to the situation where two years' numbers of a journal are bound into one volume. In this connection we should recall that where the name-number system is used the date is included under "literature cited," and it is as easily made accurate and definite by the name-date as by the name-number system. Furthermore, the name-date system keeps before the reader the information regarding the date of publication, which is an aid in evaluating in many instances.

Undoubtedly no one bibliographic system is perfect, nor will it cover all the exceptional cases. Certain possible improvements were suggested in the August 30 issue of Science. An additional suggestion is the desirability of using bold-faced type to designate the volume number. The advantages of giving the full titles under "literature cited" and of giving a definite and uniform position to each of the four items —name, date, title and literature reference—are again emphasized. This latter suggestion varies from the form used by various journals mainly in placing the reference itself upon a new line in each case rather

than letting it follow the title as is now frequently customary.

Although the writer prefers the name-date system, he is more interested in the matter of uniformity among the different journals. Dr. Merrill apparently agrees with the idea of the desirability of uniformity. If a uniform and improved bibliographic system, the printing expense of which will not be more than the value received, may be cooperatively evolved and adopted, the purpose of the writer's original article will have been accomplished. Such a result can not, however, be accomplished without cooperation in relinquishing certain cherished bibliographic forms by practically all those interested.

Since the foregoing part of this note was written, an editorial has appeared in the January 20 issue of the new edition of *Industrial and Engineering Chemistry* emphasizing the need of standardization of literature references. The present writer believes that a standard form of bibliography and citation should be based upon the preference of those who search the literature with due regard to the preference and convenience of the publisher and printer. The opinions expressed by Dr. Merrill and by *Industrial and Engineering Chemistry* are more from an editorial viewpoint. Those most interested and most affected are the research man, the author and the teacher who use the literature as a basis for scientific progress. An expression of opinion from a large number of men who are interested primarily from the investigators' standpoint should be obtained. Following the adoption of a standard system authors should be required to conform before their papers are considered for acceptance. Let us hope that further consideration may result in the adoption of a uniform standard system for all scientific journals.

J. L. ST. JOHN

STATE COLLEGE OF WASHINGTON

ATTACK BY A SCREECH-OWL

IN the SCIENCE issue of November 1, 1929, there was a short article by Mr. Albert M. Reese, of West Virginia University, about an attack of a screech-owl on several residents of Morgantown, West Virginia.

About 1915, on a farm in north central Mississippi, I had a somewhat similar experience. A colored boy about fifteen years of age complained to me that he was being attacked from the air by some mysterious birds in a wooded section along a creek. These attacks were experienced by the boy between sundown and dark. I went with him the next evening after the complaint was made to the place where the attacks had occurred. Down swooped the birds over our heads, making sounds like some one slapping two thin boards together. They tipped the top of my head several times but did no harm. We scared them off with sticks after they had made many attempts to scratch our heads. I went back to the same place on several evenings for new experiences, even though it did make the cold chills run up my spine to be attacked from the air by birds that I could not see until they were right on me. I took my gun along one evening, and again without warning the attack was on. I saw an object move on a branch of a tree about ten feet from the ground and I fired. Down came a young screech-owl. From then on there were no more attacks by the parents of this young owl. My idea is that screech-owls will attack people only when they have a nest or young birds around. Screech-owls are like many other birds, in that they protect their young ones even after they begin to fly.

W. W. CHAPMAN

PHILADELPHIA, PENNSYLVANIA

MARMOSA AS A STOWAWAY AGAIN

IT seems worth while to add still another note concerning the finding of this small Marsupial, Marmosa (known as the mouse opossum), on a banana stalk in a grocery store. This time it is quite a family group, the female and a litter of nine young. They were found here in a store in Waco, Texas. It was impossible to learn whether the bananas had come from Porto Rico or Central America since the jobber had both in the warehouse.

In this case the interesting feature is the large size of the litter. Rather large litters might be expected from opossums, but the other cases reported have been much smaller. Dr. L. A. Adams, of the University of Illinois, in SCIENCE of February 24, 1928; Professor Geo. Wagner, of the University of Wisconsin, in SCIENCE of April 20, 1928, and Professor Robert K. Enders, of Missouri Valley College, in SCIENCE of April 25, 1930, have all mentioned one or two young with a female. Mr. E. R. Warren in SCIENCE of April 20, 1928, mentions a litter but not the number. It is also interesting to note that the adults reported are females. This may be due to the fact that the female attempts to hide with the young and does not escape before or during the shipment.

The color of the fur of the adult in this case is a golden brown with darker lines through the eyes. The young are almost pure brown. All nine are carried on the back and sides of the mother. They cling to the fur with their mouths and feet and occasionally are aided by the prehensile tail. The mother has been seen to toss the young from the floor to her back with her nose, and the young grasp the fur of her back upon alighting.

G. E. POTTER

BAYLOR UNIVERSITY

QUOTATIONS

THE PEKING SKULL

THE arrival of the official report on the Peking skull and the opportunity we now have of studying the undeveloped cast of it, which recently arrived in England, enable me to answer the many queries I have received as to the reasons for attaching to the discoveries in China the exceptional importance defined in my letter to *The Times* two months ago.

(1) *Sinanthropus* comes from a geographical area in which previously early man was unknown. While the remains are of approximately the same age as *Pithecanthropus* and *Eoanthropus,* the Man of Peking is generically distinct from both the Ape Man of Java and the Piltdown Man.

(2) The jaws and brain-case found at Chou Kou Tien reveal features some of which were hitherto unknown in any human skull except *Pithecanthropus,* while others were regarded as distinctive of the Piltdown skull. Hence the newly discovered specimens provide a link between these two types and reconcile what hitherto has been their puzzling lack of conformity with one another. Thus they give cohesion to our knowledge of the earliest human remains and add stability to our conception of the qualities likely to be found in the earliest common ancestor of all three, the as yet undiscovered Pliocene Man.

(3) The Peking skull was found, not in gravels where broken fragments were scattered and deposited by running water (as happened in the cases of the Java and the Piltdown skulls), but in the floor of a cave where the Man of Sin actually lived and died. Hence the association of the human remains with those of the early Pleistocene animals found alongside them is certain, and affords for the first time unquestionable evidence that the remains of Early Man do really belong to the Lower Pleistocene. Moreover, the conditions under which the bones were found suggest the probability that other parts of the same skeletons may be found during the further excavation of this site.

(4) The fact that the skull was found in an uncrushed state and in a form less incomplete than those of *Pithecanthropus* and *Eoanthropus* gives us a fuller and more convincing idea of the form of the brain-case in one of the earliest types of mankind, and corroborates the essential accuracy of the reconstruction of the Piltdown skull made by Sir Arthur Smith Woodward in 1912.

(5) The temporal region of the Peking skull presents features of quite exceptional interest and importance. It is much more primitive than that of the Piltdown skull, and reveals a striking resemblance to the condition that is normal in the adult anthropoid apes, and some analogy to that of the modern human infant. The features of this part of the skull (which unfortunately is unknown in the case of *Pithecanthropus*) afford new and emphatic testimony of the closeness of the kinship of man and the anthropoid apes.

(6) The fact that this skull was found in Eastern Asia does not settle the problem as to the original cradle of the human family. Long before the emergence of man, anthropoid apes (whose facilities for rapid migration were strictly limited by their lack of adaptability to new conditions) had wandered as far as Western Europe, South Africa and Eastern Asia. One can therefore assume that in Pliocene times primitive men, distinguished by the characteristically human qualities of greater adaptability and freedom of movement, had roamed throughout the same extensive territory as their less enterprising Simian ancestors had previously explored. Hence the three widely differentiated genera of Early Pleistocene Man found respectively in Java, England and China represent the scattered descendants of ancestors who had already been wandering east and west throughout the vast Euroasiatic continent for hundreds of thousands of years before any one of the three genera left the skulls in the places where they have recently been found. Hence the evidence they provide has little relevance to the determination of the birthplace of the Human Family.—G. ELLIOT SMITH *in the London Times.*

SCIENTIFIC BOOKS

Titanotheres of Ancient Wyoming, Dakota and Nebraska. By HENRY FAIRFIELD OSBORN. U. S. Geological Survey, Monograph 55, 1930. 2 vols., 4to, xxiv + 953 pp., 236 pls., 797 figs.

THE titanotheres are without doubt one of the most interesting of mammalian groups. Commencing in the early Eocene with hornless forms, some of which were no larger than a coyote, they increase rapidly in size and numbers, reach a climax in the huge horned types of the lower Oligocene and then, at the peak of their development, abruptly disappear. Their size and abundance and the fact that their center of evolution appears to have been our Western states have facilitated the collection of large quantities of material and rendered possible a more complete account of their evolutionary history than is the case with any

other vertebrate group except the equids. Published facts on the group, however, have been widely scattered in the literature, and no comprehensive account has ever been given.

In consequence, the appearance of Professor Osborn's monograph has been eagerly awaited. Begun by him in 1900, it was sent to press in 1919 and finally has appeared this spring.[1] The delay has been long; but it is forgotten when one sees the magnificent work which has eventually appeared. For completeness and breadth of treatment the monograph leaves nothing to be desired. As to its thorough nature, one need merely cite the magnitude of the work: nearly a thousand pages of quarto text, more than two hundred plates, nearly eight hundred text figures. Every angle of titanothere evolution has been comprehensively treated. But the monograph is more than its title implies, for the various aspects of the subject have led the author into interesting discussions of many topics of a broader nature. It can not, I think, be questioned that Professor Osborn's hopes will be fulfilled in that the monograph has set a new standard of broad, thorough and exhaustive research in vertebrate paleontology, and that it will exercise a permanent influence upon future studies of the geological history of the great West.

The work may be, for purposes of review, divided into three sections. Chapters I to IV deal with introductory matters; in Chapters V to VIII the facts concerning titanothere morphology are set forth, while in Chapters IX, X and XI the data are summarized and applied to the solution of adaptational and evolutionary problems. In addition, a short appendix brings the work up to date with an account of recent discoveries of titanotheres in Mongolia.

In Chapter I, "An Introduction to Mammalian Paleontology," Professor Osborn, using the perissodactyls as examples, outlines the problems to be met with and his method of attack. He gives an interesting discussion of systems of classifications. In the days of Linnaeus, when evolution was undreamed of and fossils were merely curiosities, taxonomy was a simple problem. A family or genus was a clear-cut group, readily definable through the presence or absence of definite characters. But to-day with an extra, paleontological, dimension thrown into the picture, definition is far more difficult, if we attempt to retain a "natural," vertical, classification. To take the case of the titanotheres themselves as an example, all the later, Oligocene types are large, heavy-limbed, horned types. If these forms were living to-day and we had no knowledge of their history, their common characteristics could be used in definition of the group. But we know, as a result of Professor Osborn's work, that the numerous Oligocene phyla have all been derived independently from small hornless Eocene forms. As our knowledge grows, definitions become increasingly difficult; there are few definite characters, for example, by which *all* titanotheres may be distinguished from the horses or rhinoceroses. It is only by tendencies towards the acquisition of certain new features and proportions that we may characterize a group.

Resulting from this situation, the main criteria upon which the author bases his interpretation of the titanothere family tree are (1) the incidence of new characters ("rectigradations") and (2) characteristics resulting from changes in proportions ("allometrons"). Rectigradations through growth become allometrons, and since new characters appear comparatively rarely in the group, emphasis naturally is placed on allometrons (as, for example, dolichocephalic and brachycephalic tendencies in the skull). The velocity with which changes of proportion take place is stressed, and apparently justifiably so, as an index to relationship.

With regard to modes of evolution, the author propounds the question as to whether there is "evidence of chance origins and chance rudiments of certain types of structure possessing sufficient survival value to establish themselves through the principle of the survival of the fittest, or whether there is some other orthogenetic principle at work causing the definite and adaptive origin of new characters."

A second chapter, treating of the geological environment of the titanotheres, covers far more ground than the title indicates, for it includes a comprehensive survey of early Tertiary stratigraphy and discussion of the division of this period of time on the basis of faunal zoning as well as an account of the physiographic, floral and faunal environment of the titanotheres. Chapter III gives a chronological account of titanothere discoveries, in which original descriptions and type figures are reprinted in full, while a short fourth chapter details earlier classifications of the group and the classification finally adopted for the monograph.

With Chapters V and VI we are plunged into the main body of the work, for these sections deal with the structure of the skull and dentition of Eocene and Oligocene titanotheres. An immense amount of material is described in the three hundred pages devoted to this topic; in many instances a dozen or more

[1] The task of putting a huge scientific work of this character through the press is time-consuming in itself. But in addition one is at liberty to suspect that the unfortunate "economies" to which the Geological Survey has been subjected during the past decade may have been a major reason for the delay. It is to the lasting credit of the survey that it has been able to publish such a work of pure science despite its straitened financial position.

skulls of a single species are figured and measurements given. Among the striking features of the titanothere skull is the extreme conservatism shown in the persistently low-crowned teeth and the small brain, in contrast with the wide range of variability in skull proportions and the almost simultaneous independent development of horns in the various phyla near the close of the group's history.

But although the skull and teeth are the center of interest, the remainder of the skeleton is by no means neglected, but is discussed in Chapter VII. However, as Professor Osborn notes, the amount of valid material is limited not only through the fact that articulated skeletons and skulls are rarely found in association but also because of the methods of early collectors, who plucked the skulls and neglected the skeletons.

A chapter on titanothere musculature, contributed by Dr. W. K. Gregory, follows. Dr. Gregory has pointed out that it is impossible fully to understand the skeleton of an animal without a proper appreciation of the muscles with which it is so intimately related. The present chapter is an illustration of the results to be obtained by this mode of attack. Using one of the common Oligocene forms as a type, the musculature, especially of the limbs and head, has been restored on the basis of careful comparative studies. Once the musculature is understood, the dry details of the skeleton become invested with new meaning. Logically following this, Chapter IX discusses the mechanics of locomotion in ungulates, the principles of leverage and muscular action and the significance of variations in the ratios of limb segments.

As in the case of the preceding sections, Chapter X goes far beyond the bounds of the titanotheres themselves in the treatment of their origin and ancestry. Following a discussion of the origin of the perissodactyls, an attempt is made to characterize a primitive perissodactyl, and the variations found in many structures are traced in all branches of the order. The facts concerning titanothere morphology presented in earlier chapters are reviewed with especial reference to their bearing on the adaptive radiation of the group.

In conclusion Professor Osborn treats of the causes of the evolution and extinction of the titanotheres. As to extinction, various reasons which have been suggested as responsible for the extermination of mammalian types are discussed, for the most part without the conclusion being reached that they have played any important rôle in the seemingly sudden disappearance of these strange animals. It is suggested, however, that a major factor may have been the fact that the teeth were inadaptive, lacking the possibility of becoming high crowned and thus permitting the titanotheres to take up the grazing habit which was rendered necessary by changed conditions.

It is only the paleontologist who has direct evidence as to the mode of evolution, and in consequence Professor Osborn's conclusions as to evolutionary processes, based upon an intensive study of titanothere phylogeny, merit serious consideration. He abandons the Lamarckian view-point held by Cope; selection is admitted as important. But to the mutation theory as held by the great majority of modern geneticists he takes objection. He holds that variations are not discontinuous and fortuitous, as the genetic evidence seems to show, but are orderly, determinate and generally adaptive. The initial appearance of new characters (rectigradations) are "timed" in the case, for example, of the rudiments of horns in various upper Eocene titanothere phyla, while in the case of changes in proportions (allometrons) "progressive brachycephaly and progressive dolichocephaly in the titanotheres point to the presence of some similarly acting influence affecting generation after generation in a similar manner." Reasoning from this evidence, he has reached his tetrakinetic theory of evolution. Germinal evolution is neither purely internal nor purely external, but a combination of the two; evolution is due to the interaction of the germinal material, the developing organism and the physical and biological environment.

While it does not seem improbable that the changes in proportions might be explained on the basis of mutation and selection, there appears to be considerable strength to Professor Osborn's argument when applied to such cases as the incidence of horns in titanotheres. The independent appearance of horn rudiments in related forms might be attributed to parallel mutations, such as have long been known to occur in various species of Drosophila; but it is difficult to see how there can have been the slightest survival value in the faint beginnings of these structures. It is unfortunate that at the time this section was written so little of the literature of modern genetics was available for discussion. However, the evidence shown for Professor Osborn's view-point by the titanotheres is fully presented in the monograph and is available for the consideration of any geneticist who may desire to attempt a Mendelian explanation.

A work of the magnitude of this monograph could not be the sole product of one man. Professor Osborn notes that Dr. Gregory has collaborated throughout in its preparation, and in the preface tribute is paid to the many colleagues and assistants who have aided in the work. The monograph is thus essentially a product of the department of vertebrate paleontology of the American Museum of Natural History; but viewed again in this light, it is again a personal triumph for

Professor Osborn. Founded less than four decades ago, the department has risen in that space of time to an unchallenged position of leadership in the field, while throughout the country there are few paleontologists who have not at some time or other been connected with this institution, few museums which have not been greatly influenced by the example set by the American Museum. The present monograph is a lasting monument to Professor Osborn's work in paleontology; but a still more enduring testimony to his labors for paleontology will be the American Museum's work and the inspiration it will continue to give to workers in the field of vertebrate history.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE METHOD FOR THE GERMINATION OF OOSPORES OF SCLEROSPORA GRAMINICOLA

THE germination of oospores of *Sclerospora graminicola* has been a subject of interest since the time of Schroeter.[1] However, no one except Magnus[1] has succeeded in germinating oospores, prior to the writer's recent investigation.[2,3] In further studies in the department of plant pathology, University of Nebraska, a simple method for the successful germination of oospores has been devised. Briefly, the method consists of placing a layer of moistened cotton in the two parts of a Petri dish. Then a small piece of moist filter-paper on which small amounts of oospore powder are placed is put upon the surface of the moist cotton in such a way that the filter-paper will partly, but not entirely, touch the cotton. Both the cotton and filter-paper must be drained of excess moisture before the oospores are added to the dish. It is essential that the space between the two layers of cotton in the dish be about one half the height of the dish. Small blocks of 2 per cent. agar-agar, on which the oospores are scattered over the surface just as the agar is hardening, can be substituted for the filter-paper. One difficulty encountered when moist filter-paper is used is that the oospores on the periphery of the mass germinate earlier and better than those in the mass.

The time required for germination is markedly different at different temperatures. For instance, the time required for germinating at 35° C. is 22 to 40 hours; at 30° C., 24 to 45 hours; at 25° C., 30 to 48 hours; at 20° C., 42 to 60 hours; at 15° C., three to four and one half days, and at 10° C., nine to ten days. The percentage of germination, of course, varies with the temperature and also to a great extent with the source and age of the oospores. Therefore, it is advisable that oospores from different sources and ages be tested. Germination has been obtained within a range of 10° to 35° C. The optimum temperature appears to be near 20° C., although in previous experiments a higher optimum temperature over a short period of time was reported.[3]

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[1] J. Schroeter, *Hedwigia*, 18: 83–87, 1879.
[2] M. Hiura, *Agriculture and Horticulture* (Japan), 4: 11–20, 1929.
[3] M. Hiura, *Jour. Plant Protect.* (Japan), 16, 5 pp., 1929.

A PRACTICAL FLAGELLA AND CAPSULE STAIN FOR BACTERIA

THE following method of flagella and capsule staining is offered as a contribution both to the teacher of bacteriology and to the technician in the laboratory. It is rapid, simple and dependable. It has been especially designed for staining *Bacillus proteus vulgaris* and *Bacillus subtilis*, common soil species, and the various members of the colon-typhoid group. The procedure is as follows.

(1) Make a thin smear of 15 to 24 hour agar growth of bacteria in a loopful of water on a clean slide. Air-dry. Do not heat. (2) Cover with mordant (5 per cent. tannic acid, 3 parts; 10 per cent. ferric chloride, 1 part) for two minutes. (3) Put seven drops of mordant in a small receptacle and add 1 drop of Ziehl-Neelsen carbol fuchsin stain. Mix. Add 1 drop of concentrated hydrochloric acid. Mix. Add 1 drop of concentrated formaldehyde. Mix. (4) Pour off mordant from slide and cover smear with the mixture prepared in (3). Apply seven minutes. (5) Wash smear in running water. (6) Cover with Ziehl-Neelsen carbol fuchsin stain (Basic fuchsin, 10 grams; ethyl alcohol, 95 per cent., 100 cc; phenol, 5 per cent. aqueous, 1000 cc) and *gently* steam for one half minute. (7) Remove stain with running water. (8) Blot and examine.

The following precautions are in order.

(*a*) Take only a minute portion of the agar growth. Do not use semidry agar. For best results add the agar growth to a drop of water on a slide, stir, and let stand for five minutes, permitting individual bacteria to become detached from the agar mass; then spread loopful on another slide and work with this second slide. (*b*) The mordant will keep indefinitely and so can be prepared in quantity. The mixture

prepared in (3) should be used fresh. (*c*) Filtered mordant and stain yield better preparations than unfiltered materials. (*d*) A small variation in ferric chloride content of mordant affects the depth of color of the flagella. (*e*) If a tube containing 2 cc of water be heavily inoculated with agar growth, it will supply hundreds of flagella smears over a period of two days.

The flagella stain described is a capsule stain as well. It stains the capsules of such organisms as *Diplococcus pneumoniae, Streptococcus fecalis* and Friedlander's bacillus when these are grown in broth.

It also stains the capsules of pneumococci recovered from the peritoneal exudate of white mice. The following procedure is recommended for staining the exudate. (1) Spread a loopful of the exudate in a loopful of water on slide. Undiluted exudate may be used, omitting the water. (2) Apply mordant described in (2) for ten seconds. (3) Wash in running water. (4) Apply cold diluted carbol fuchsin stain for ten seconds. (5) Wash with water, blot and examine.

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SPECIAL ARTICLES

AN ATTEMPT TO PRODUCE MUTATIONS BY THE USE OF ELECTRICITY

THE calculations made recently by Muller and Mott-Smith[1] indicate that high frequency radiations are not the only cause of mutations. It is, therefore, desirable that a further search be made for other causes. On account of its wide distribution in nature, its wave properties and the fact that it travels at enormous speeds, electricity, and especially high frequency electricity, offers a good field for investigation in this connection.

Two tests have been conducted at the Agricultural and Mechanical College of Texas to determine whether or not mutations can be produced with electricity. The organism used in these experiments was *Drosophila melanogaster*. The well-known C1B method of Muller was adopted. It offers an excellent technique for studying any new agency as a possible causative factor in the production of mutations.

In the first experiment, which was conducted in 1928, the flies were treated in a field between two concentric copper cylinders. It was found necessary to cover one end of the opening with cheesecloth and to pass a strong current of air through the space between the cylinders to remove the gases produced by the electricity. Otherwise the flies were killed by the gases. The peak voltage was 33,000 volts at 60 cycles, giving a voltage gradient from 25,000 volts per cm at the surface of the inner cylinder to 7,000 volts per cm at the inner surface of the outer cylinder. Treatments for various lengths of time from one minute to thirty minutes were given.

The treatment had very obvious immediate effects on the flies. Some were killed. Those which were not killed were so affected that nearly all lost control of themselves. The legs usually became tangled. A fly so affected would lie on its side apparently trying to untangle its legs. Some of the flies recovered in a few minutes and became normal in their actions. Others required as long as twenty-four hours in which to recover their equilibrium. Still others died without ever becoming normal again. Some of those which did recover were sterile.

A total of 172 daughters of treated males were mated. Not a single case of a lethal mutation was observed.

The progeny of these females, that is, the F_2 generation from the treated flies, was examined in detail for visible effects. A white-eyed female was found in one of the cultures. This was not a contamination, because this fly was gray whereas the only stock of white-eyed flies in the laboratory at that time was yellow. Several peculiar variations in wing size and shape were noted. An example is the blister wing occurring as the left wing of one female. This wing stood out from the body, had six veins instead of the normal four and had a blistered or bubble-like area covering about one sixth of the wing.

These results were not conclusive in either direction. Enough effects were observed, however, to warrant the repetition of the experiment on a larger scale.

This was done in the spring of 1930. The adult males were treated this time in an electrostatic field of a potential equal to the breaking-down point of air, or 30,000 volts per cm, a total of 225,000 volts at a frequency of an oscillating current of 1,225,000 cycles per second. Care was taken to prevent the current from breaking over.

The flies were held in the field confined in small cheesecloth bags. An attempt was made to hold the flies in gelatin capsules while treating them. However, the current was observed to go around the capsule, hence the adoption of the cheesecloth bags.

One minute was the longest time it was found practical to expose the flies in this field. This is the length

[1] H. J. Muller and L. M. Mott-Smith, *Proc. Nat. Acad. Sci.*, 16: 277–285, 1930.

of treatment that was used. This treatment killed half the flies exposed to it and rendered still others useless for breeding.

Sixty-nine fertile matings were made with treated males. Ten C1B daughters from each male were mated in individual cultures, making 690 matings producing 100,000 flies which were observed for lethal mutations. In no case where large numbers of progeny were produced were any lethal mutations observed. Three matings showed no males, but each of these produced only two or three females, hence showed nothing significant.

Thus far the results are of such a nature as to indicate that very probably mutations can not be produced by the use of electricity, at least of the particular kinds used in these experiments.

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THE FECUNDITY OF THE OYSTER[1]

IT is a well-known fact that many marine invertebrates, especially those that discharge the eggs into the water where fertilization outside of the organism occurs, produce large numbers of sex cells during a spawning season. The estimation of the total number of eggs developed in a single female is of certain scientific interest, but unfortunately it presents considerable difficulties. In the case of the oyster, which is known to be extremely prolific, the attempts to determine the number of eggs produced by one adult female were made by Möbius[2] in 1883 and Brooks[3] in 1880. Möbius's method consisted in weighing first the whole mass of the embryos which were scraped by means of a small brush from the gills of the female, then in weighing and counting the number of embryos in a small portion of it. He estimated that the average number of embryos in each of five full-grown *Ostrea edulis* from Schleswig-Holstein was 1,012,955. This figure is less than that given by Eyton,[4] whose estimate was 1,800,000. Brooks estimated the number of eggs in the American oyster, *Ostrea virginica*, by determining the total volume of eggs washed out of the ovary and by measuring the dimensions of eggs. He arrived at the conclusion that an oyster of average size developed more than 9,000,000 eggs. An unusually large oyster, according to his computation, would possibly produce 60,000,000 eggs in one summer. Nelson[5] thinks that a large oyster, "if fat the preceding spring, undoubtedly would mature from 50,000,000 to 60,000,000 eggs in a season."

During the course of the experiments on the spawning of oysters in which the writer was engaged during last summer and fall opportunity presented itself to enumerate the eggs laid by *O. virginica* and *O. gigas*. Experiments with the American oysters were carried out at Woods Hole; those with the Japanese species (*O. gigas*) were made at the Hopkins Marine Station, Pacific Grove, California. Japanese oysters were shipped from Samish Bay, Puget Sound, to Pacific Grove where they were kept for about a month in the laboratory tanks. *Ostrea gigas* grows very well in Samish Bay, but in spite of good development of the gonads, fails to spawn there.

Female oysters, placed in twenty-liter glass tanks filled with sea water, were stimulated to spawn, and kymograph tracings of the spawning reaction, which is characterized by the rhythmical contraction of the adductor muscle, were obtained. After the reaction was over, the water in the tank was stirred with a powerful electric stirrer and a 100 cc sample was taken. Eggs, killed by addition of a few drops of 1 per cent. osmic acid, were counted, using the Sedgwick

NUMBER OF EGGS DISCHARGED AND DURATION OF SPAWNING REACTION OF *O. virginica* AND *O. gigas*

Oyster No.	Length cms	Width cms	Date 1929	Temp. ° C.	Duration of reaction, minutes	Number of contractions	Average number of eggs per contraction, millions	Total number of eggs discharged in one spawning period, millions
O. virginica			July					
292	13.3	10.5	23	22.5	61	56	1.26	70.3
295	9.2	7.0	24	24.0	36	57	0.53	30.3
299	11.2	8.0	24	23.0	70	75	0.20	15.0
302	9.4	6.6	25	25.0	70	135	0.85	114.8
O. gigas			Oct.					
J–2	15.2	6.9	2	25.0	23	31	1.34	41.5
J–2	15.2	6.9	9	30.0	23	47	0.83	39.0
J–2	15.2	6.9	19	30.0	19	44	0.26	11.4
J–16	9.5	6.1	20	27.5	15	.....	.....	30.4
J–20–1*	11.6	6.8			59	121		
J–20–2*	10.9	6.2						
J–20–3*	11.2	6.8	22	25.3				55.8**
J–20–4*	12.0	4.8						
J–20–5*	10.8	7.4						

* Five females were kept together; kymograph tracing obtained from one oyster only.

** Average per female; total number discharged by five oysters, 278.8 millions.

[1] Published by permission of the U. S. Commissioner of Fisheries.

[2] K. Möbius, "The Oyster and Oyster Culture," Appendix H to the Report of the Commissioner of Fisheries for 1880, pp. 681–747, 1883.

[3] W. K. Brooks, "Development of the American Oyster," Johns Hopkins University, Studies from the Biological Laboratory, No. IV, p. 81, 1880.

[4] T. C. Eyton, "History of the Oyster and Oyster Fisheries," London, 1858. Quoted from Brooks, *loc. cit.*

[5] T. C. Nelson, "Aids to Successful Oyster Culture," New Jersey Agricultural Experiment Stations, 1921, Bulletin 351, p. 59, 1921.

Rafter method for enumeration of plankton organisms. Each time five samples were taken and the average was computed. The figures are accurate within ± 10 per cent. The results of the experiments are presented in the table.

An examination of the table shows that the number of eggs laid by the female *O. virginica* during one spawning period varied from 15 to 114.8 millions. Inasmuch as the author's experiments show that the female can be induced to spawn five or six times during the season it is permissible to assume that the number of eggs discharged during one spawning period represents only a fraction of their total number in the organism. It is quite probable that the maximum number of eggs in a single adult female may be close to one half of a billion. An examination made immediately after the spawning of oyster No. 302, which had discharged 114.8 millions eggs, has shown that the oyster still contained vast numbers of eggs, the thickness of the gonad layer being about 0.7 cm.

The number of eggs discharged during one spawning period by the Japanese oysters varied from 11.4 to 55.8 millions. The last figure represents the average number of eggs discharged by five oysters used in the experiment J–20. It was noticed, however, that during this experiment the four oysters which were in the tank together with the oyster No. J–20–1 contributed but a very small portion of eggs, probably not more than one fifth of their total number. Oyster No. J–2, which was induced to spawn three times on October 2, 9 and 19, discharged altogether 91.9 millions of eggs.

The results of the experiments with two species of oyster show that the actual number of eggs developed each summer by the female oyster is much greater than was previously estimated by Brooks.

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U. S. BUREAU OF FISHERIES

THE OIL ABSORPTION OF SHELL EGGS

SHRINKAGE, due to the loss of carbon dioxide and moisture, is the greatest economic factor encountered in the cold storage of shell eggs. The following is a brief preliminary report of work done in the food research division of the Bureau of Chemistry and Soils on the problem of reducing shrinkage, by the use of mineral oils.

Eggs were dipped in oil, some at atmospheric pressure, others under a vacuum. To facilitate macroscopic observation of penetration, the mineral oils used were colored with Sudan IV, an oil-soluble dye. Penetration was particularly noticeable around the air cells.

Soxhlet ether extractions of shells and membranes were made to determine quantitatively the oil absorbed by the shells and by the membranes. The normal quantity of ether-soluble extract in unoiled shells and membranes was found to be approximately 1 per cent. The normal quantity of fat in the membranes of unoiled eggs was found to be from 3 to 4 per cent. and in the shells (freed of membranes) less than 0.1 per cent. (Percentage was based on weights of individual samples.)

Eggs dipped in oil at atmospheric pressure for 2 minutes were found to contain approximately 10 times more ether-soluble extract in the combined shells and membranes than did the untreated eggs. The quantity of ether-soluble extract in the membranes, however, was found to be only slightly greater in the treated eggs than in the untreated eggs.

No difference in the quantity of absorption was found between the shells and membranes of brown eggs and those of white eggs.

Eggs dipped under a vacuum of 50 mm for 1 minute were found to contain approximately 13 times more oil than the untreated eggs. The quantity of ether extract in the shells of these eggs was found to be about 7 times greater than in untreated eggs and approximately the same as in the shells of eggs dipped at room pressure. The quantity of ether extract in the membranes was found to be approximately 5 times greater than in the membranes of untreated eggs and 4 times greater than in those dipped at atmospheric pressure.

Unoiled eggs, as well as eggs dipped in oil both at ordinary atmospheric pressure and under vacuum, were stored at 98° F. for 10 days, and weighed at 48-hour intervals for the detection of shrinkage. The unoiled eggs lost about 13 per cent. of their total weight in 10 days. Those dipped at atmospheric pressure in plain colored oil at 100° F. for 2 minutes lost approximately 2 per cent. of their weight. Eggs dipped in 2 per cent. aluminum soap oil under 50 mm of vacuum at 100° F. for 1 minute and stored at 98° F. for 10 days lost only 0.5 per cent. Almy, Hepburn and Macomber[1] reported that eggs dipped in oil containing 2 per cent. aluminum soap and stored at 40° C. for 12 days lost 6.2 per cent. of their weight.

These studies on the oil treatment of eggs are being continued.

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